Report on the Second Field Data Acquisition in Chiang Mai, Thailand, January 20-26, 2002

By

Cuizhen Wang and Jiaguo Qi
Basic Science and Remote Sensing Initiative
Department of Geography
Michigan State University
East Lansing, MI 48823

Introduction

To continue our ground data acquisitions for validating forest density in the context of our NASA-LCLUC funded project at Michigan State University (GOFC Data and Information for Tropical Forest Assessment and Management (PI – Jiaguo Qi)), a second trip was made to collect detailed forest characteristics in the dry season. This trip has double duties: 1) Continued fractional cover training on product accuracy and new development, and 2) more detailed forest data in the dry season to address seasonal variations on fractional cover estimation. The field equipment used is the same as in the firs field trip, with assistant from our collaborators in Thailand. Please consider this report as a draft. Analysis of this data set is being made at the time of this writing.

Additional sites were selected this time along dirt trials so that the areas far away from the main roads can be sampled. Within a 7-day period, more sites were visited in a much longer distance this time than previous field trip. There were overall 35 sites visited during this trip and the biophysical attributes measured included:

1) Ten (10) sites were revisited at exactly the same location as the first trip in August 2001. At these sites, only fisheye pictures were taken along the 100m transect to calculate forest fractional cover;
2) Twenty five (25) new sits were established and forest characteristic data were collected using the same protocol developed from the first trip. Namely they include GPS readings nearby roads, ten (10) samples along 100m transects, and the nearest 4 trees in four directions were selected to measure tree height, canopy height, canopy density, DBH, and Fisheye pictures were then taken at each site. In addition, with the help of the field guider and students, tree species were recorded and tree ages were estimated.

I Sites Distributions

The sites and Ground Control Points (GCP) were marked in Fig.1. Due to the time limit, most of the sites were centered in Doi Inthonam, and expanded in Mae Chaem, Mae Klang, and Mae Wang sub-watersheds. The Mae Samoeng sub-watershed was not visited.

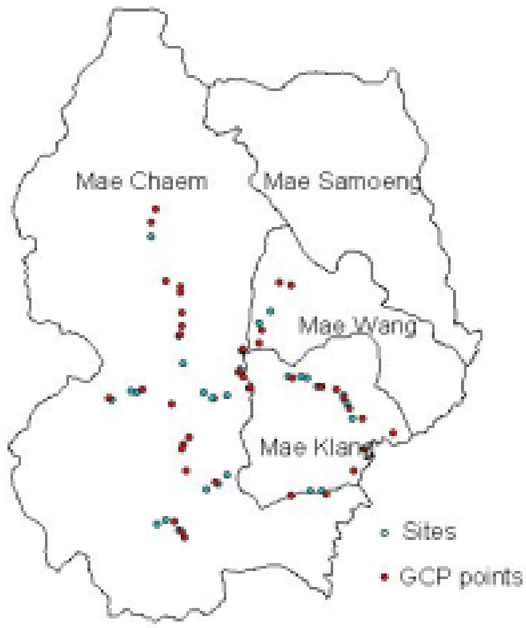


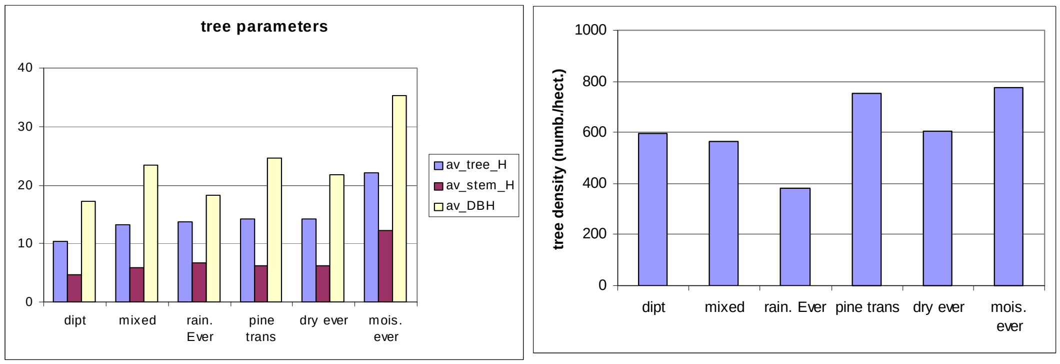
Fig.1 Location of sites and GCP points in Field Trip 2.

II Field Measurements

Among the sites visited in this trip, there were 5 main forest types: Dry dipterocarps (9), mixed deciduous (9), pine transition (5), dry evergreen (6) and moist evergreen (4). Additionally, there was one (1) site of tropical rain evergreen, distributed along the river valley, and one (1) site of teak plantation, small patches in downhill. Most of the forests in the study area were within the Doi Inthanon National Park, centered in Mount Doi Inthanon. The profile of forest types as a function of elevation is shown in Fig.2.

Fig.2 Spatial distribution of forest types along elevation.

Fig.3 shows below the biophysical attributes of the forests at our study sites. They include tree height (m), canopy height (m), DBH (cm), and tree density (#/hectare). It is obvious that the attributes of moist evergreen are much larger than other forest types.



(a) (b)

Fig.3 Distribution of measured forest attributes for each forest type: tree height, canopy height, and DBH (a), and tree density (b).

Each value in Fig.3 was the average of several sites, while each site was averaged over 10 samples. Four trees were measured in each sample, in 4 directions. All species with DBH > 10cm were treated as tree, the remaining were either seedlings or saplings. Young trees are always inevitable species in any ecosystem, therefore the overall trend in Fig.3 was highly smoothed.

These measured forest biophysical attributes are correlated. For example, both DBH and tree age values positively increase with tree height (Fig.4a, 4b), tree density is negatively related to age (Fig.4c). Compared with its spatial distribution, tree height increases with elevation with a weak positive correlation (Fig.4d).

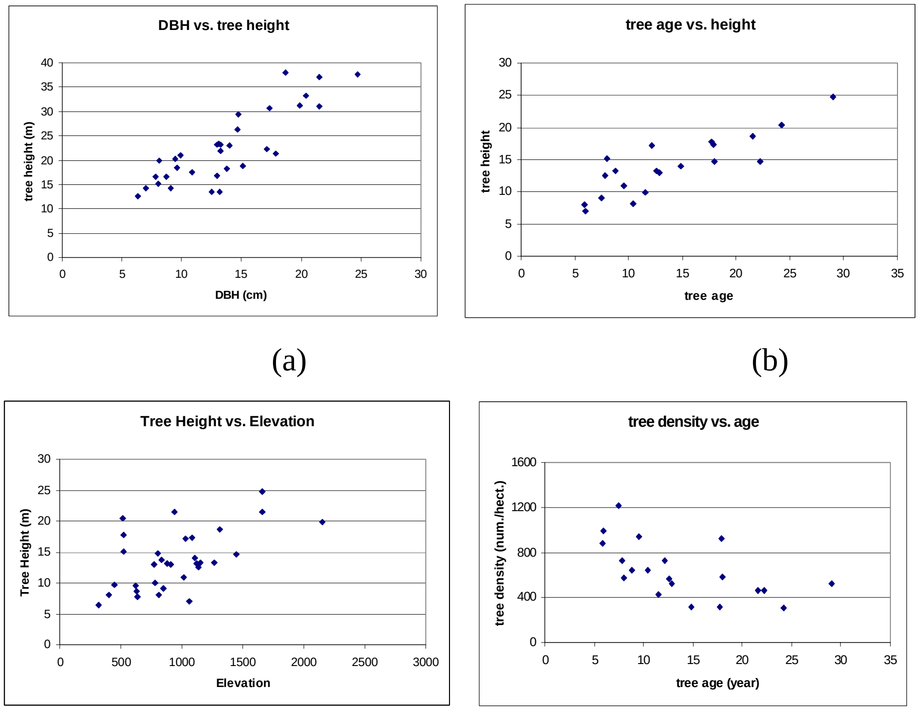


Fig.4 Relationships between forest biophysical attributes and spatial distribution.

III Fractional Cover Computation

Fisheye pictures were taken at each sample, and processed with Gap Light Analyzer (GLA) to calculate fractional cover (*fc*). The *fc* is strongly correlated with elevation but becomes insensitive at high elevations (Fig.5).

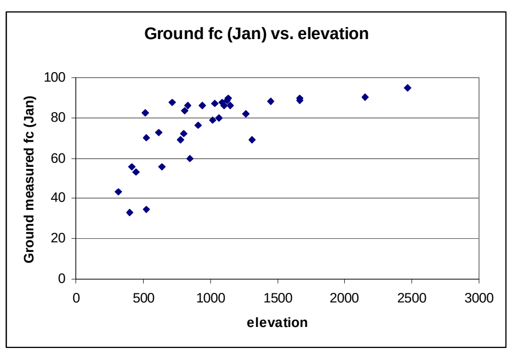


Fig.5 Relationship between fractional cover and elevation.

As mentioned before, the study area was in dry season during this trip. For species like dry dipterocarps and some others in mixed deciduous, the leaves began to become yellow and started dropping off. This phenology is in great contrast with that in the first field trip which was in a wet season (August 2001) and leaves were green and healthy. Therefore, for the dipterocarps and mixed deciduous sites, the *fc* values measured from this trip were lower than those from the first field trip, but there were no significant differences among evergreen forests (pine transition, dry evergreen, and moist evergreen) sites as indicated in Fig.6.

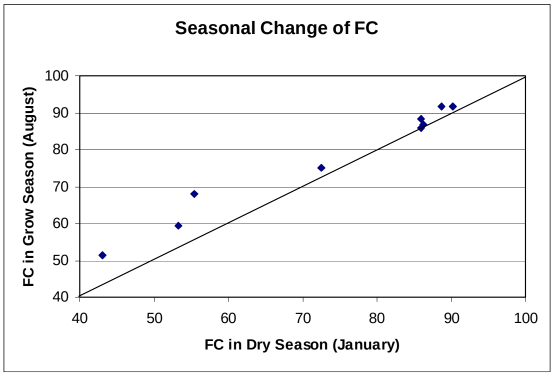


Fig.6 Comparison of fractional cover between dry (January) and wet season (August).

Fractional cover estimates were calculated from fisheye pictures using the Gap Light Analyzer (GLA) software. After registered in a circle and divided into sky sections in certain numbers of azimuth and zenith regions, the picture is threshold into black and white. The sky openness is the percentage of white area in the circle (Fig.7).

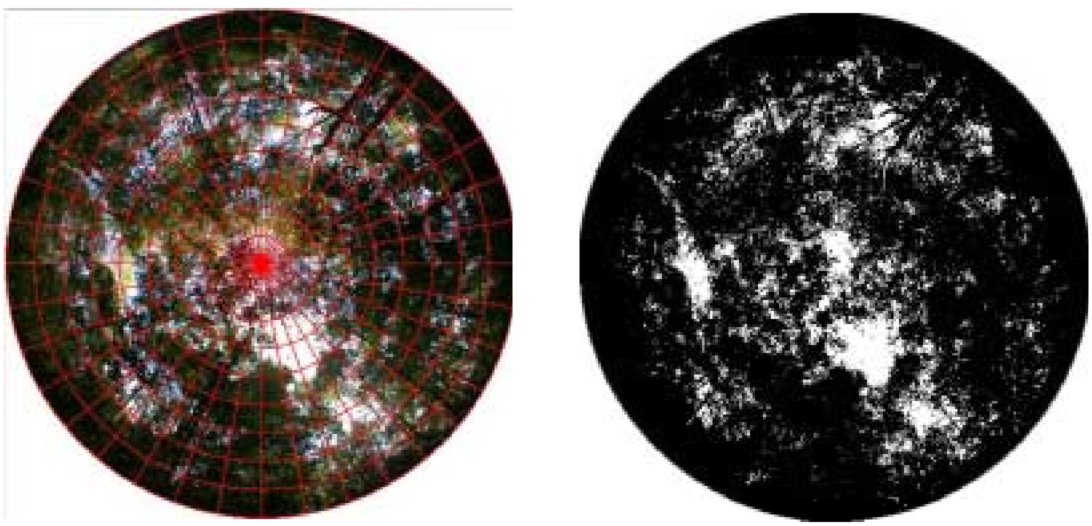


Fig.7 Calculate fractional cover in GLA software.

Although powerful and popular, the GLA software cannot be used to handle the variable environmental conditions. These deficiencies decrease the accuracy of fractional cover calculations. For example, during the sunshine daytime, the area nearby the sun becomes hotspot, a large white area in the black and white graph (Fig.8). Therefore, the resulted sky openness is higher than the reality. Topographic effect is another important source of errors in calculating fractional cover. The area blocked by mountain is black in the threshold image and this resulted in overestimates of fractional cover (Fig.9).

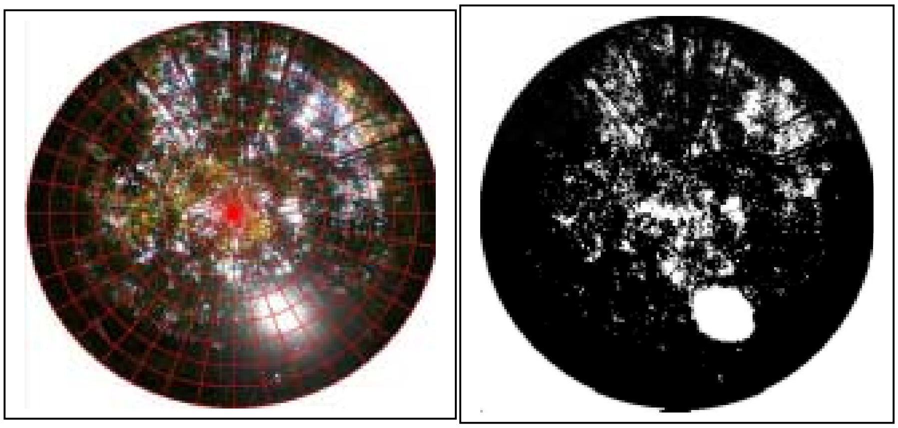


Fig.8 Sun hotspot effect in GLA.

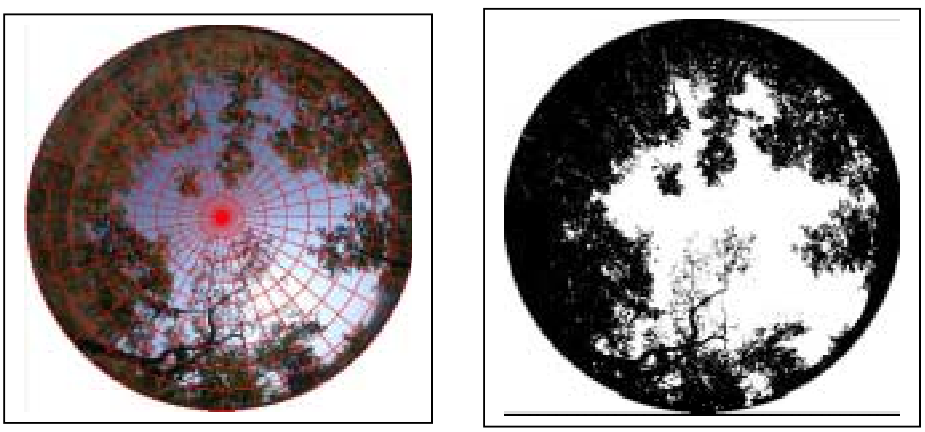
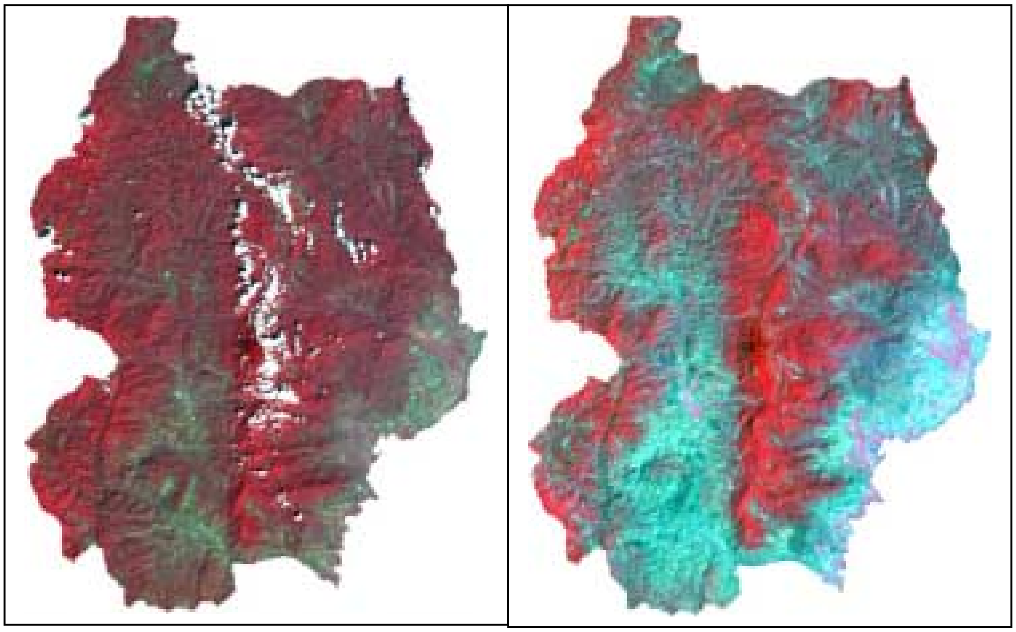


Fig.9 Topography effect of GLA.

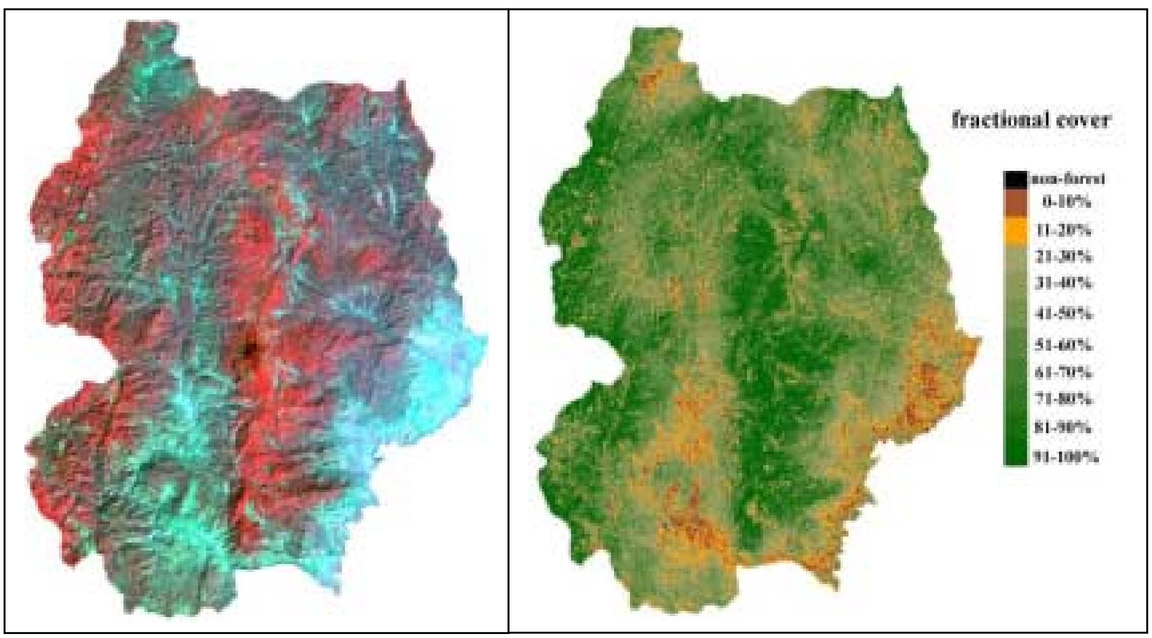
IV Comparison between Ground and ETM+ Derived *fc*

The main objective of the fieldwork was to collect ground truth data to validate the fractional cover map derived from ETM+ image. After the trip, one ETM+ image (Fig.10a) was acquired on Feb. 2, 2000 and was processed to estimate canopy fractional cover. The pixels covered by cloud were replaced by the ones in March 5, 2000 image (Fig.10b), assuming that since the cloud-covered areas were mostly evergreen forests in the mountains, the pixel values did not change significantly within in one month period. The new image and the resulted fractional cover map are in Fig.11. Each pixel value on the *fc* map represents the fractional cover in an area of 30×30m.



(a) (b)

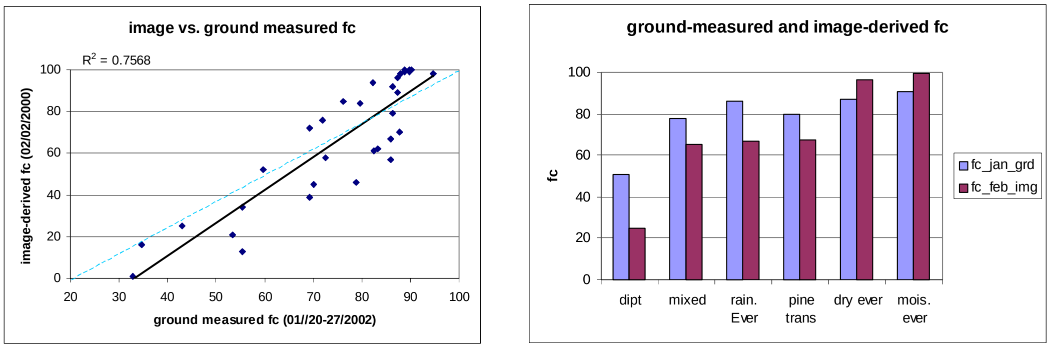
Fig.10 ETM+ images acquired on Feb. 2000 (a) and March 5, 2000 (b).



(a) (b)

Fig.11 Cloud-free image on Feb.2, 2002 (a) and estimated fractional cover map (b).

The image-derived and ground measured factional cover fit well (R^2 = 0.76) (Fig.12a). However, the image-derived fractional cover is underestimated in the lower end, and a little over-estimated in the upper end. This trend is also obvious in Fig.12b.



(a) (b)

Fig.12 Comparison between ground measured and image derived fractional cover.

The fractional cover estimation from vegetation index (MSAVI) is green fractional cover. It depends on the intensity of the spectral response of green leaves. The image was acquired in February, dry season in the study area. Therefore, the leaves of deciduous species, such as dry dipterocarps and some in mixed deciduous, have become yellowish and dropped off. The MSAVI value of these forest types are very low, so as to the estimated fractional cover.

The ground based fractional cover, however, depends on the sky openness. Regardless the topographic effect and other distortions, it is the combination of leaves and stems, trunks, etc (Fig.13). For example, at a leaf-off dipterocarps site, the image-derived fractional cove should be very low (0- 20%), but the value from GLA picture is 44%.

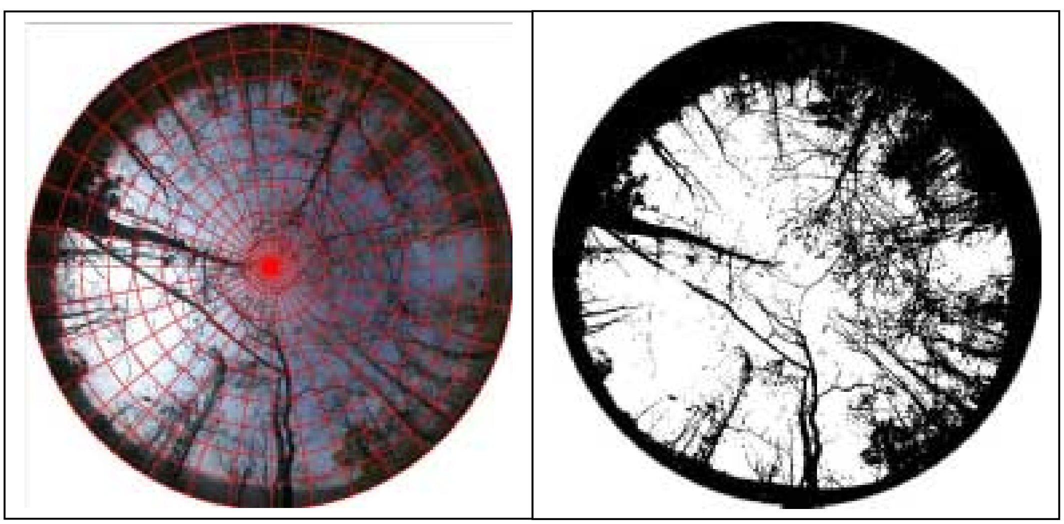


Fig.13 Fractional cover calculation in a leaf-off site.

As for the high end in Fig.12, there still have some descriptive difference. GLA calculation is based on the hemisphere projection above horizon, and there is always certain portion of sky openness no matter how dense the forest is. The image-derived fractional cover, however, get saturated at the area of dense healthy green forests.

V Further Perspectives

In the study area, four scenes of ETM+ imagery have been acquired during 2000 and 2001 period in wet and dry seasons. During this time period, two field trips have been made in January (dry season) and August (wet season). Therefore, it is possible to evaluate the seasonal change of fractional cover in the region.

The seasonal changes are different among forest types. For example, dry dipterocarps are totally leaf-off in dry season, mixed deciduous are partially changed, and evergreen may remain the same in the whole year. The fractional cover map should be adjusted differently in each forest type.